ASA
AUTO SKILLS AUSTRALIA

Tools and Equipment

THIS LEARNER WORKBOOK SUPPORTS THE AUTOMOTIVE COMPETENCY UNIT:

AURTTK002 USE AND MAINTAIN WORKPLACE TOOLS AND EQUIPMENT

WHS/OHS Training
We recommend that learners complete the WHS/OHS unit **AURASA002 Apply safe working practices in an automotive workplace** before commencing this study.

Safety Disclaimer
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Australian Government
Department of Industry

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Introduction

Welcome to Tools and Equipment based on competency unit **AURTTK002 Use and maintain workplace tools and equipment.**

Study Overview

Work on automotive vehicles is totally linked to the use of tools. While you will get your hands dirty working on vehicles, most tasks you perform will involve one or more tools. Naturally, a good knowledge of both **what tools are** called and **what they do** is essential.

A lot of your learning for this study will be linked with other tasks – we won't ask you to remember every tool and what it does until you've had time to use each tool yourself. Using the correct names comes very quickly and easily if you are working 'hands on'.

You will learn about:

- Hand tools, their function and their maintenance
- Power tools, their function and their maintenance
- Other pieces of equipment such as hoists and jacks and again – what they do and how they should be maintained.
- PPE – what to wear and when to wear it. Often it's easiest to wear most PPE all the time when you're in the workshop.

And, you will learn how to work in a mechanical workshop and use the right language.

Tools and equipment, like cars, are getting 'smarter' all the time. Doctor Who uses a sonic screw driver to measure and adjust more or less everything in the universe. We'll never have a sonic screw driver but devices like the Digital Multimeter can measure up to 10 features of an electric circuit with a simple turn of the dial. You may be the last to use some of the tools we see today. Your children may wonder what you're talking about when you mention a hand drill and a screw driver. Which tools do you think will disappear first?

Project

Your skill and knowledge with tools and equipment will develop over the months and, possibly, years that you work in the automotive industry. To 'kick –start' that development it is recommended that you undertake one or two projects that require you to use tools and equipment and allows the time to explore and make a few mistakes without any serious consequences.

Your instructor will work with you to decide which project/s you will do. Here are some suggestions:

- Disassemble and reassemble a skate board, bike or scooter
- Disassemble and reassemble a motor mower
- Remove and refit a motor in a car or light vehicle (This might also be a wheel assembly or rear axle on a front-wheel drive car).

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Assessment
When you undertake this study you will be required to complete the following assessment tasks. If you complete them successfully under the auspices of a registered training organisation (RTO) you may be awarded a statement of attainment for the competency unit **AURTTK002 Use and maintain workplace tools and equipment.**

Assessment Tasks
The assessment tasks you will complete for recognition against the competency unit AURTTK002 Use and maintain workplace tools and equipment are:

1. Workbook activities – completion of the Hand and Power Tool Safety section and the Proficiency Matrix

2. Thirty question online test

3. Eleven demonstration tasks which will include:

- five different hand tools
- two different power tools
- two different air tools
- vehicle lifting equipment
- vehicle supporting equipment.

Your state or territory education authority may require additional or different assessment activities to complete this study.

As you select and use tools you will select the right PPE to reduce the risks that these tools and equipment present. The materials and supervision necessary to complete these tasks will be supplied by your instructor.

Numeracy and Literacy
Auto Skills Australia (ASA) has a number of resources in development including studies for the development of foundation skills in Literacy and Numeracy. ASA recommends the completion of a foundation program of studies before attempting this Learning Resource. In particular this learning resource has been developed with the assumption of a successful completion of basic numeracy and literacy including competency unit ARU2001 Use numbers in an automotive workspace.

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Topic 1 – Hand and Power Tool Safety

There is another study in this series on workplace health and safety which covers all aspects of safety in an automotive workshop. As a result we want to look at the aspects of safety that relate to the activities in this 'tools and equipment' study.

1.1 Hazard Tagging

Tagging is used to let other people know about a risk. The tag is used to ensure that a faulty piece of equipment is not used or that switches are not turned on when they could cause injury. These tags are used extensively in electrical trades but they can be used by anyone to control risks.

Isolation (lock-out) procedures - Red

You should use isolation or lockout procedures to prevent another person activating any equipment, valve, electrical supply, switch or tap which may place you in danger. Ask your Supervisor about the isolation procedures applicable to your workshop. A system of personal **danger tags or locks** and **out of service tags** is commonly used in most work locations.

When there are two or more employees working on the same equipment **all** employees must attach their own danger tag.

A Lockout System may also be used in conjunction with a Danger Tag. This enables the employee undertaking work that may place them at risk to attach a lock preventing the isolating switch from being activated.

The only person who can remove a Danger Tag or personal Lockout device is the person who placed it.

Out of service tag - Yellow

The out of service tag is used to identify equipment that is faulty or equipment that is being serviced. It can be placed by **anyone**. It can also be **removed by anyone** that has made the equipment safe. It **does not** offer any personal protection. The out of service tag is primarily used to warn others of hazards.

Electric vehicles generate electricity whenever they are moved which can cause a variety of secondary hazards including electric shock. Tagging is particularly important for these vehicles.

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1.2 Safety Guidelines

There are many aspects to safety in the workplace. You will have already looked at this in detail in the safety module. Here we will look at specific safety issues involved in using tools.

Safety Guideline	Comments
Keep work area clean	Cluttered work area and benches invite accidents.
Avoid dangerous environments	Do not expose power tools to rain.- Do not use power tools in damp or wet locations and keep work area well lit. In a gaseous or explosive atmosphere, sparks from an electric tool may ignite fumes.
Keep children away	All visitors should be kept at a safe distance from work areas
Store idle tools	When not in use, tools should be stored in dry, high or lock-up places, out of reach of children
Do not force a tool	It will do the job better and more safely at the rate for which it was designated.
Use the right tool	Do not force a small tool or an attachment to do the job of a heavy duty tool.
Wear proper apparel	Loose clothing or jewellery will get caught in moving parts. Rubber gloves and foot wear are recommended when working outdoors.
Use safety glasses when using power tools	Also, a face or dust mask if the cutting operation is dusty.
Do not abuse cord	Never carry the tool by the cord or yank it to disconnect it from a receptacle. Protect the cord from heat, oil and sharp edges.
Secure work	Use clamps or a vice to hold work. It is safer than using your hand and it frees both hands to operate the tool.
Do not over reach	Keep proper footing and balance at all times.

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Safety Guidelines (Con't)

Safety Guideline	Comments
Maintain tools with care	Keep tools sharp and clean at all times for best and safest performance. Follow instructions for lubricating and changing accessories.
Disconnect tools	Disconnect when not in use, before servicing, or when changing accessories such as blades.
Remove adjusting keys and wrenches	Form the habit of checking to see that keys and adjusting wrenches are removed from the tool before turning it on.
Avoid accidental starting	Do not carry a plugged in tool with a finger on the trigger or switch. Be sure the switch is off when plugged in.
Outdoor use of extension cords	When a tool is used outdoors, use only extension cords suitable for outdoors.
Inspect power cords before using them	Inspect them for loose or exposed wires and damaged insulation.
Always use an earth leakage protection device	When extension cords or power tools are being used in the open or camp situation, the chance of damage or current leakage to the frame of the tool or the material being machined is very high

Risky Business

When have you done the wrong thing and put your safety at risk? Talk about this with your group. What sorts or injury or damage could have resulted from you doing the wrong thing?

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WHS for Tools and Equipment
You will remember the steps in safety hazard management:

- Identify the hazard
- Assess the risk in terms of consequences and likelihood
- Control and monitor the hazard

For each hazard listed below, assess the risk and say how to control the hazard and monitor it.

Your instructor may recommend attempting only a few of these

Hazard: Cluttered area and benches

Risk assessment

Controls & Monitoring

Hazard: Expose power tools to rain or moisture

Risk assessment

Controls & Monitoring

Hazard: An explosive atmosphere

Risk assessment

Control & Monitor

Hazard: Visitors in work areas

Risk assessment

Controls & Monitoring

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Hazard: Storage of tools

Risk assessment

Controls & Monitoring

Hazard: Forcing tools – to cut faster, drill deeper, cut harder material

Risk assessment

Controls & Monitoring

Hazard: Loose clothing or jewellery

Risk assessment

Controls & Monitoring

Hazard: Material hitting eyes

Risk assessment

Controls & Monitoring

Hazard: Misuse of tool cord

Risk assessment

Controls & Monitoring

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Hazard: Work not secured

Risk assessment

Controls & Monitoring

Hazard: Over reaching – to complete a task

Risk assessment

Controls & Monitoring

Hazard: Poor maintenance of tools

Risk assessment

Controls & Monitoring

Hazard: Tools left connected to power

Risk assessment

Controls & Monitoring

Hazard: Adjusting keys and wrenches not removed

Risk assessment

Controls & Monitoring

DRAFT

Hazard: Accidental starting

Risk assessment

Controls & Monitoring

Hazard: Outdoor use of extension cords

Risk assessment

Controls & Monitoring

Hazard: Condition of extension cords

Risk assessment

Controls & Monitoring

Hazard: Earth leakage

Risk assessment

Controls & Monitoring

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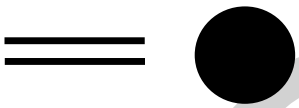
Topic 2 – Selecting, Operating, Maintaining and Storing Tools and Equipment

2.1 Selecting

Selecting the right tool for a given job is a skill that develops with time. Here are some of the factors you should consider:

- Don't use a spanner for a hammer – at the very least use the right type of tool for the job – spanner for a nut, screw driver for a screw
- Get the scale right – don't use a 20mm screwdriver on a 40 mm screw.
- Follow the manufacturer's guidelines - the table below gives an example of selecting the right hacksaw blade for the material type and cross-section.

Selecting the Right Tool: Hack Saw Tooth Size (Teeth per Inch or TPI)

Material to be Cut **Section & Size**	**Soft Materials - Brass, Copper, Aluminium, Bronze**	**Medium Hardness Material - Mild Steel, Medium Carbon Steel**	**Hard Materials - Alloy Steel, High Carbon Steel**
 Up to 3 mm	24 TPI	32 TPI	32 TPI
 3 – 6 mm		24 TPI	24 TPI
 6 – 13 mm	18 TPI	18 TPI	24 TPI

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2.2 Cleaning

Hand Tools

As a general rule, we all know how to clean tools. To ensure that we are all on the same wavelength here are some guidelines for cleaning hand tools.

1. Fill a bucket with hot water and commercial cleaner - as indicated on the product instructions.
2. Add tools and soak for 30 minutes.
3. Use a wire brush to scrub the tools wearing rubber gloves
4. Dry tools thoroughly.
5. If any of your tools have rust on them, use the steel wool to rub the rust off.
6. Once every 6 months, apply a thin coat of oil by pouring some on a soft rag and wiping the tools down.

This process would only be used for a major clean up. For daily use and cleaning a quick wipe with a dry cloth should be sufficient.

Power Tools

DON'T put power tools in a bucket of water! Power tools can be cleaned in a number of ways:

- Simply wiping with a cloth to remove surface oil and dust
- Using a vacuum or air jet to remove dust build up
- Wiping with a cloth and a little solvent such as kerosene
- Disassembling and cleaning individual parts – especially if the tool is not functioning properly
- According to manufacturer's guidelines

A visual inspection should tell you when a power tool needs cleaning – build ups of oil, dust and metal shards are easily seen.

Cleaning Up

Explore your workshop for tools that need cleaning now or in the near future. What method would you use?

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2.3 Storage

Generally, hand and power tools should be stored:

- Securely on a shelf or rack
- Out of reach of children
- In clean, dry conditions
- Locked in a room or locker, if possible
- According to manufacturer's guidelines

http://organizeyourstuffnow.com/wordpress/31-days-loving-live-day-26-garage

It is common practice to apply a thin coating of oil on many tools to avoid rust. Check the manufacturer's guidelines for advice on this.

2.4 Periodic checks – testing and tagging out

All power tools should be tested and tagged by a qualified electrician on a regular basis. Generally this period is 6 months although this varies from time-to-time and state-to-state in Australia. Power leads should also be checked.

Before you use a power cord or tool check its tag for currency.

Hand tools should be checked for rust of other damage every 6 to 12 months. You will normally check any hand tool you use each time you use it.

Any tool that shows sign of excess wear or does not function correctly must be 'tagged out' until the fault is rectified.

http://www.eece.uwa.edu.au/students/safety/elec3307/safe-environment

Out of service tag

The out of service tag is used to identify equipment that is faulty or equipment that is being serviced. It can be placed by anyone. It can also be removed by anyone that has made the equipment safe. It does not offer any personal protection. The out of service tag is primarily used to warn others of hazards.

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2.5 Power Tool Operation

To get the best results from any portable tool, you should remember the following points:

- Clamp movable material down
- Allow the tool to reach full speed before bringing it to the job
- Lift tools clear of the work before switching off
- Don't stop tools when they are still working on the job
- Keep the cutting edges of tools sharp
- Listen to the sound of the motor for changes in pitch or tone - a droning or slowing motor sound means an overloaded tool.

No safety eyewear!

Electrical Insulation

Earthing portable electric tools protects the user from electric shock. There are two common systems of insulation:

- Single-insulated – have an earth pin in the plug
- Double-insulated – no earth pin in their plug (as shown)

Three Pin – Single Insulation

Two Pin – Double Insulated

Earthing

Do not earth double-insulated tools or all insulated tools. They are totally enclosed in a casing made of tough plastic or similar material, with no metal parts exposed.

Portable electric tools which are double- insulated or all-insulated, are clearly marked with the words: **DO NOT EARTH**

Tool Leads and Extension Leads

All electrical leads must be checked and tagged before they can be used. The tag will tell you if it is current. Always check the tag before using a tool.

Inspect all leads before use. If the casing or conductor wires of a lead are broken or damaged the lead must be repaired and tagged by a qualified electrician.

Extension leads should be inspected and tagged regularly according to government regulations.

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Adopt a tool
Select a hand tool from your work shop then:

- Clean it
- List its functions
- Research it – what variations are there? Bigger or smaller, electric or manual, old and new
- Teach yourself and/or learn how to use it
- Select the PPE required to use it
- List any other hazard management controls needed when you are using it
- Explain your tool to your training group

Tool name

Tool Functions

Research notes

PPE Required

Hazard Management Controls

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Topic 3 - Building 'proficiency'

'Proficiency' is a word we use to describe a person's overall ability to do something – like using tools and equipment. It is like 'skill' but it goes further and includes choosing the right tools, maintaining tools and avoiding injury or damage from tools. Your proficiency in using a wide range of tools will grow as you spend months or years working in the automotive industry. Part of this proficiency is physical skill and part of it is knowledge.

In this study you will use tools and equipment to complete several projects. The main purpose of this study is to start building your proficiency with tools and equipment. Your physical skills will come from completing the projects. Your knowledge will come from talking about and writing information about tools and equipment.

By the end of this study you should know more about:

- Uses of tools and equipment
- Working safely with specific tools
- Types of tools and equipment within each main category
- Selecting the correct tool from the range available

The main categories of tools and equipment include:

- Allen Keys
- Spanners including socket sets, torque wrenches & adjustable wrenches
- Oil Filter removal tools
- Screw drivers
- Pliers
- Hammers
- Chisels and punches
- Hacksaws
- Files
- Impact screw drivers
- Bench grinders
- Drills
- Fasteners including bolts, washers, nuts, studs & screws
- Lifting equipment including floor jack, air jack, hoist
- Specialised tools including screw extractors, gear and bearing pullers

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3.1 Hand and Power Tools Proficiency Matrix

In the pages that follow you will document the tools you will use in this Certificate II qualification. The information you need to do this is supplied in the Reference Information pages **BUT** additional information can be obtained from the internet. You may also learn about the tool from your instructor or fellow students when you use it. Include this information as well.

Sample Activity - Sockets and Ratchets

Uses of tool

- Loosen or tighten nuts/bolts
- Ratchet action and handle give extra leverage
- Ratchet action means the nut can be loosened or tightened without having to release for each turn

Operation

- Select the correct sized socket piece
- Attach ratchet handle
- Use adaptor for small sockets

Maintenance

- Clean socket and handle after use
- Store in the correct location on box
- Store socket box horizontal to avoid spillage
- Ensure lid is firmly closed

Types

- Size of set varies
- Size of sockets varies
- Materials and quality will vary
- Little other variation between socket sets

WHS/OHS

- Standard workshop PPE in particular
- Safety goggles
- Steel toed boots

Online Responses

An online facility will be available to record your answers with the formal release of these learning resources.

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Activity 1 - Spanner

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 2 - Adjustable Wrench

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 3 – Socket and Ratchet Handle

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 4 - Torque Wrench

Function

- .....

Operation

- .....

Maintenance

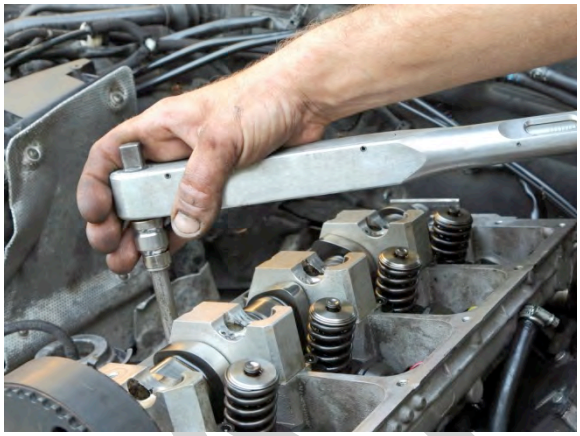
- .....

Types

- .....

WHS/OHS

- .....
- .....



Comments

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Activity 5 - Oil Filter Remover

Function **Operation** **Maintenance**

- ..... - ..... - .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 6 - Allen Keys

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 7 - Screwdrivers

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 8 - Pliers

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 9 - Hammer

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 10 - Cold Chisels and Centre Punch

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 11 - Hacksaw

Function **Operation** **Maintenance**

- .....

- .....
- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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DRAFT

Activity 12 - Files

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 13 – Fastening Hardware

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 14 - Power Screwdrivers, Drills and Wrenches

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 15 – Bench and Angle Grinders

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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DRAFT

Activity 16 – Drill Bits

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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DRAFT

Activity 17 - Air Drill and Wrench

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....

Comments

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Activity 18 - Jack Stand and Hoist

Function

- .....

Operation

- .....

Maintenance

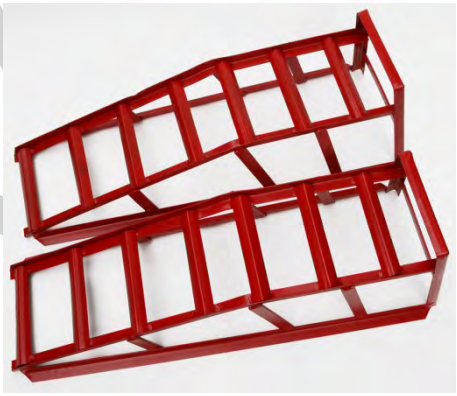
- .....

Types

- .....

WHS/OHS

- .....
- .....



Comments

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Activity 19 - Sealants and Adhesives

Function

- .....

Operation

- .....

Maintenance

- .....

Types

- .....

WHS/OHS

- .....
- .....
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Comments

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Activity 20 - Specialised Tools

There are many specialised tools used in a mechanical workshop. Some are for a special task; some are for a particular make of vehicle. Here are two tools used in most workshops to work on gear boxes and to extract damaged or broken screws.

Tool Name	Function	Appearance
Gear Puller	•	•
Screw Extractors	•	•

Identify another specialised tool not described anywhere else in this book.

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Topic 4 - Reference Information

You will be developing your proficiency in a range of tools and equipment. In this section you are supplied with information which will help you achieve proficiency. In some cases there will be everything you need. In other cases you will need to use the internet, each other and your instructor to get everything you need.

Hand tools – anything that doesn't require an external energy source – just some 'elbow grease'.

Power Tools - covers power tools which use either electricity or air pressure to work.

Using Reference Information

On the following pages you have been supplied with information on each tool and piece of equipment used in this study.

You will use this information, along with your practical experience to complete the proficiency matrix in the pages above.

As you will find, there is a lot more to each tool than we can include in these few pages. It will help your development as a proficient automotive technician if you research tools and equipment on the internet and take care to watch how tools and equipment are used in your training workshop.

http://blog.hemmings.com/wp-content/uploads//2013/01/McPherson_700.jpg

DRAFT

4.1 Spanners

There is such a large range of spanners that anyone starting a tool kit must look carefully at the type of work that will be done and select spanners to suit. A good trades person will get many years of service from a set of spanners. In fact, some spanners are guaranteed unconditionally, provided they are not used in conjunction with power tools.

The correct size spanner should always be used in a way that will ensure that it will not round off the corners of the nut or bolt head. The length of a spanner is made to suit the strength of its jaws; a spanner could be damaged if a piece of pipe or another spanner were used to gain more leverage.

Safety

Do not strike spanners with a hammer. This will cause damage and possible injury if the spanner slips off the fastener. The exception is the single-end spanner which is designed for that purpose.

Always “pull” on a spanner. Never “push” a spanner. If it is necessary to push a spanner, do so with an open palm.

It is dangerous to use a tool that does not fit correctly. Skinned knuckles or even worse injury could occur, not to mention damage to the work and tool.

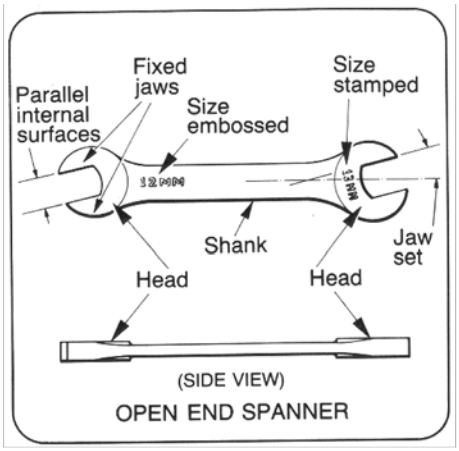

Image adapted from MEM18.1A Use hand tools

Open End Spanner

The double-ended open-end spanner is the most common spanner. It is easy to use and is quick to slip on and off the head of a bolt or nut. It is used to advantage where many turns are required and where the spanner can be turned without hindrance.

Tube or box spanner

This is a special spanner for use in confined space where a socket is restricted by a long bolt.

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Half Moon Spanners
A half moon spanner is made from the same type of material and with production methods similar to those used to make a standard ring spanner.

The heads are not at an angle to the shank but the shank is bent at two points so the heads are displaced by 35 and 75 degrees to the centre line.

A half moon spanner is used to reach around parts to loosen or tighten a bolt or nut.

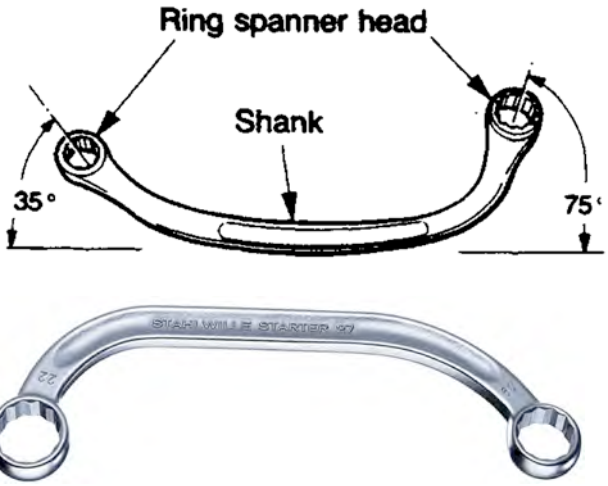
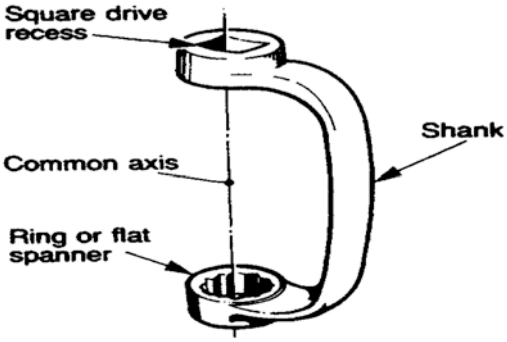


Figure 1 Half Moon Spanners



Crow Foot Spanners

Crow Foot Spanner
A crow foot spanner has a standard ring or flat spanner at one end and a square drive recess at the other end. The shank is bent at a right angle in two places so that the drive recess is on the same axis and directly above the ring or flat spanner end.

Another version is basically the head of a spanner, with the handle replaced by a square drive recess.

The crow foot spanner is used to loosen or tighten a nut or bolt that cannot be reached with a normal spanner.

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4.2 Socket Spanners

The socket spanner provides the most positive grip and the quickest action of all spanners. The12 point (double hexagon) is the most often used of the socket spanners because it provides location at 12 different angular positions. These spanners are available in a number of drives, namely:

- 1/4 in. for light applications, refrigeration, air conditioning, etc.
- 3/8 in. and 1/2 in. for most engineering applications, automotive work, etc.
- 3/4 in. and 1 in. for heavy industrial, trucking, earth-moving equipment, etc.

Sockets

Chrome finish is for general use, while a black finish indicates an impact or power socket.

Sockets can be used with a range of tools such as rackets or speed bars to provide either speed or torque, depending on the application.

Always ensure that the correct size socket is selected to avoid damage to the socket or the head of the fastener. Never use a standard socket with an impact wrench.

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1. Universal Joint

2. Ratchet

3. Speed Brace

4. Handle

5. Extension

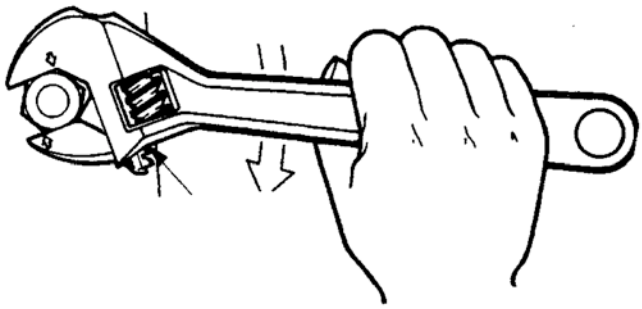
Socket Spanner Accessories

Sockets often require the use of many accessories and are usually kept in sets all having the same sized square drive. A socket set may include the following:

1. Universal joint - Used to ensure that the socket always sits on the nut correctly.
2. Ratchet - Allows a nut or a bolt to be tightened or loosened without removing the socket.
3. Speed brace - Used to quickly remove or replace nuts and bolts
4. Handle - Used to initially loosen a nut or a bolt which is very tight.
5. Extension - Used to extend the reach of the socket.

4.3 Adjusting or Shifting Spanners

Shifting spanners are not intended for heavy use and are not recommended if a spanner of correct size and configuration can be found. When using a shifting spanner the force should be applied against the fixed jaw. The shifter is available in a range of sizes to suit most hexagons and square nuts and bolts. It is not as strong as a spanner and must be used with care to prevent it slipping off and causing injury and damage.



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4.4 Torque Wrenches

They were designed to prevent over tightening bolts on water main and steam pipe repairs underground in 1918 in New York.

From Wiki - Replace

Torque wrenches are used to allow the operator to measure the force or torque (rotational force) applied to a bolt to meet the specifications of a manufacturer or service manual.

Beam type

The simplest form of torque wrench consists of a long lever arm between the handle and the wrench head, made of a material which bends elastically in response to applied torque. The deflection at the handle is proportional to the applied torque. The torque applied can be read from a manual gauge – as shown.

From Wiki Replace

Electronic torque wrenches

Torque measurement is made by a strain gauge attached to the torsion rod. The torque reading is converted to the required unit of force (Nm in Australia) and shown on the digital display.

Video – 'How to use a torque wrench' (on a bike) at http://www.youtube.com/watch?v=187IHhDF9qE

Operation and Safety

The operation of a torque wrench is very straightforward – simply tighten the fitting (nut, bolt or screw) to the prescribed setting which can be read from a gauge. You may need to zero the gauge before use if there is residual deflection evident – i.e. it is not reading zero.

Safe operation requires you to wear standard workshop safety clothing including footwear and goggles for eye protection. The torque wrench is inherently safe if you only tighten to the manufacturer's specification.

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4.5 Hex/Allen Key

Use and Operation

They are used on hex screws, such as button head screws, set screws and drain plugs to loosen or tighten the screw.

Variety and Selection

This tool is made from hexagonal bar stock.

The correct size is determined by measuring across the flat.

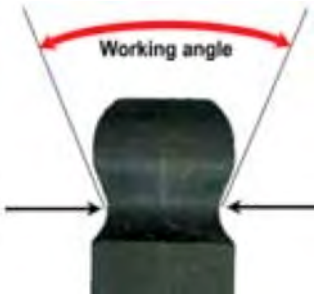
Usually it comes with a 90 degree bend in it, but is also available straight with a T handle or as a socket drive.

These tools are also available with a ball end so fasteners can be accessed on an angle.

Safety

If the ends become worn the tool must be replaced.

T Handle Allen Keys



Hex Screw

©Auto Skills Australia

4.6 Screwdrivers

Screws are used to fix a vast array of components on a vehicle. The screwdriver is a blade at the end of a shaft fitted to a handle. It is used to tighten or loosen a screw. The blade is shaped to fit into the head of a screw.

Variety

The two common types of screwdriver are the slotted head or Phillips head but there are a number of screw types – as shown.

Slotted

Phillips

Pozidrive

Torx

Hex

Robertson

Some of the less well known blade types are made specifically to limit access to a power tools or other electronic equipment's internal workings – usually because of the risk of damage or injury.

Operation and Safety

Operation is simple – insert the blade in the head of the screw and turn – one way to loosen and the other to tighten. Things to consider include:

- match the blade to the screw head size,
- use the correct style of blade (don't jam a straight blade into a pozidrive
- don't over tighten – use a torque wrench ratchet with a screw head

The only substantial safety risk is slipping – usually when applying excessive force. Cuts or punctures may result. And, wear the basic workshop PPE whenever using tools.

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4.7 Oil Filter Remover

An **oil filter** is designed to remove contaminants from engine oil. They increase the life of engine oil but they must be replaced on a regular basis.

http://www.toolstation.com/shop/Automotive/Mechanics+Tools/Oil+Filter+Wrench+5765mm/d60/sd180/p67000a

Oil filters are usually a cylinder shape which screws into place. Their shape makes them difficult to grip. A device called an oil filter remover has been developed to solve this problem. The key component is the circular steel belt which can grip the oil filter allowing it to be screwed off its position on the engine block.

Spin-on oil filter, showing seal and screw-on thread

Variety

A quick search on the internet will show that there are many types of oil filter to match the many ways the oil filter can be attached. The example shown is a 'traditional' assembly.

Operation and Safety

The oil filter wrench is used under a vehicle or at the very least in the engine bay. It is simply attached and then used to rotate the oil filter off or on to the engine. You will need to check and select the appropriate oil filter wrench for the make of car you are working on – keeping in mind there is a wide range of types.

Wear workshop PPE – clothes, boots, etc. A means of cleaning up oil spills should be handy – this could be as simple as a convenient cloth but a spills kit with portable bunding is ideal. Wear gloves and goggles to avoid any spillage problems. Ensure that the engine is cool – engine oil at operating temperature can cause serious burns.

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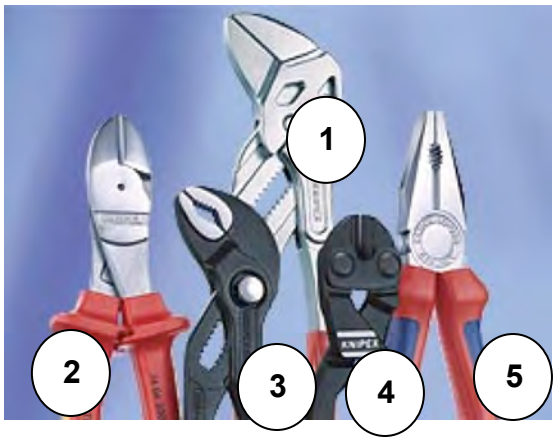
4.8 Pliers

Pliers are used to hold small components our hands are too big to control. Pliers can also be used for shaping or cutting light metal – sheets or wire.

In the figure we can see:



Variety and Operation

1. & 4. Bolt Cutters – as the name implies, these are highly leveraged pliers for cutting thick metal such as bolts

2. Side Cutters – these pliers are exclusively for cutting wire and thin metal.

3. Slip Joint Pliers – adjustable pliers used only for holding.

5. Combination Pliers – used for holding, cutting and manipulating small objects

Pliers are mainly gripping tools designed to hold work that can't be held satisfactorily by hand.

Application of Combination Pliers – Holding, Gripping Wire, Cutting.

Safety

Standard workshop safety measures are generally sufficient for this group of tools. Gloves will provide some additional protection when using larger tools.

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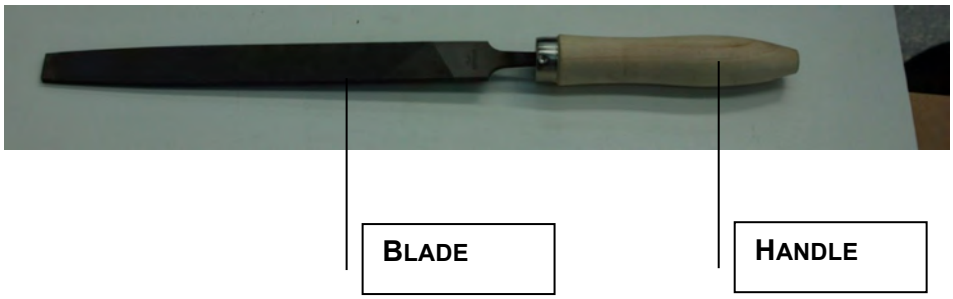
4.9 Files

Files have many applications such as shaping small parts, trimming parts to fit together, removing marks and preparing surfaces for finishing.

Files are made of high grade steel. During manufacture they pass through the processes of forging to shape, grinding of the surfaces, cutting of the teeth, hardening and tempering.



Variety

There are four basic types of file based on their teeth type.

- **Single** cut files have a single set of teeth running diagonally across the file.
- **Double** cut files have two sets of teeth running diagonally across the file creating a diamond shaped pattern.
- Single and double cut files are made in three grades of cut: bastard – coarse cutting, second cut and smooth – fine cutting.
- **Dreadnought** cut files have coarse, curved teeth and are used for cutting soft metals such as aluminium and lead.
- **Rasps** have raised individual teeth and are used for reducing material quickly. They leave a very coarse finish

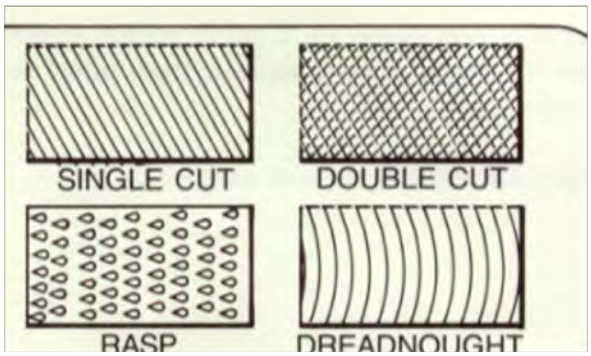


Image adapted from MEM18.1A Use hand tools

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Operation
There are three simple actions to remember when using a file. The images below show the correct hand positions to use.

Heavy

Apply strong force on the forward stroke and allow the return stroke to slide easily over the surface

Light

Apply firm force with finger tips on the forward stroke and allow the return stroke to slide easily over the surface

Finishing

Guide the file gently with fingertip control applying light force on the forward stroke only

Safety
Files pose only a slight risk of injury to the hands. Gloves can be worn but they do limit the ‘feel’ of the filing action which could produce a les

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4.10 Hacksaws

Hacksaws are used for cutting metal. They have a blade made out of very durable material with fine teeth.

Variety

1. Low tungsten steel blades are used for general purpose sawing of mild steel, copper, brass, aluminium and similar metals. Use this type of blade when first learning to use a hacksaw.

2. High speed steel blades provide for fast cutting and maximum blade life. They should always be used for sawing alloy steels, heat treated steel and other hard metals.

Selection

The table below gives a general guideline for selecting the right blade for the material type and cross-section.

Material to be Cut **Section & Size**	**Soft Materials** **Brass, Copper, Aluminium, Bronze**	**Hard Materials** **Alloy Steel** **High Carbon Steel**	**Medium Hardness Material** **Mild Steel** **Medium Carbon Steel**
Up to 3 mm	24 TPI	32 TPI	32 TPI
3 – 6 mm		24 TPI	24 TPI
6 – 13 mm	18 TPI	24 TPI	18 TPI
13 – 25 mm	14 TPI	18 TPI	14 TPI

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Using a Hacksaw

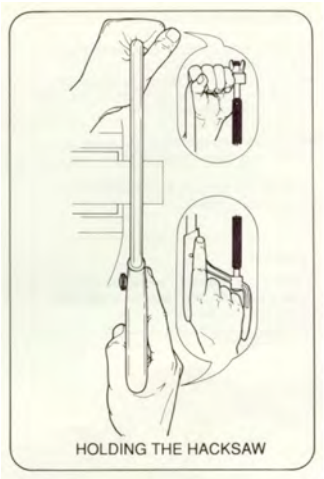
- Hold the handle in the right hand with the thumb on top and the index finger below.
- Press the handle into the palm of the hand with the remaining three fingers.
- With the left hand lightly grip the front end of the frame just above the wing nut.
- The hacksaw shown has a rigid fixed frame.

Note, in all types of hacksaws, fit the blade so that the teeth face away from the handle. The teeth cut on the forward stroke only.

Hacksaw Safety

Use these tips to ensure that you control all hazards associated with hacksawing:

- Pay attention when using a hacksaw. Should the blade cut through suddenly or break there is a danger of striking your hands
- Wear safety goggles when sawing. Pieces of metal can fly from a blade that breaks.
- Use a brush to clear chips away. Keep the inside of tubes and recesses free of chips when sawing.
- Take special care when the cut is almost through. Arrange for the support of the material being cut off if it is liable to move and jam the blade.
- Beware of sharp edges left after cutting. Use a file to smooth off the edges.
- Store the hacksaw so that you can pick it up without striking your hand on the teeth.
- Never test the sharpness of the teeth by rubbing your fingers on them.


HOLDING THE HACKSAW

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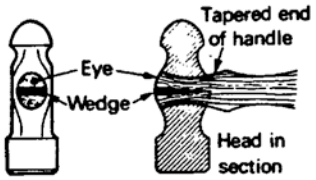
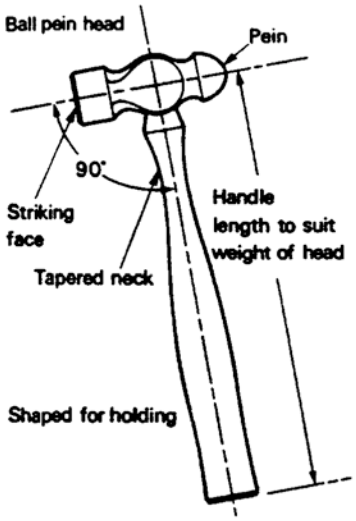
4.11 Engineer's Hand Hammers

It might seem that one hammer is the same as all other hammers. This is not the case. Hammers can do quite a lot of damage to a vehicle if the wrong hammer is chosen for a task.



Head wedged on handle



Variety

The heads of engineers hand hammers:

- range in weight from 100 grams to 1.4 kg
- are made of high grade steel
- have two hardened and tempered striking ends, which are:
    - a face for general work such as striking chisels and punches; and
    - a pein for special work such as riveting.

Good hammer handles are made of hickory, ash or similar strong elastic material with:

- a length to suit the weight and purpose of the head;
- a tapered shock-absorbing neck behind the head; and
- a good shape for holding at the far end.

When the head is correctly fitted, the handle will:

- have its axis at right angles to the head in both planes; and
- be wedged firmly into the eye.

The wedge should be across the narrow diameter of the eye or at not more than 45° to the narrow diameter.

Operation and Selection

For work to be done with the striking face, the weight of the head is the main factor.

Light hammers are easy to control but are not suitable for applying heavy blows. Heavy hammers are tiring to use and it is difficult to strike light accurate blows with them.

- Use heavy hammers up to three pounds for tasks requiring a lot of energy, such as bending heavy bars and striking large cutting tools.
- Use one and a quarter or one and a half pound hammers for general work.

Use light hammers about half-pound for light accurate work such as tapping small punches.

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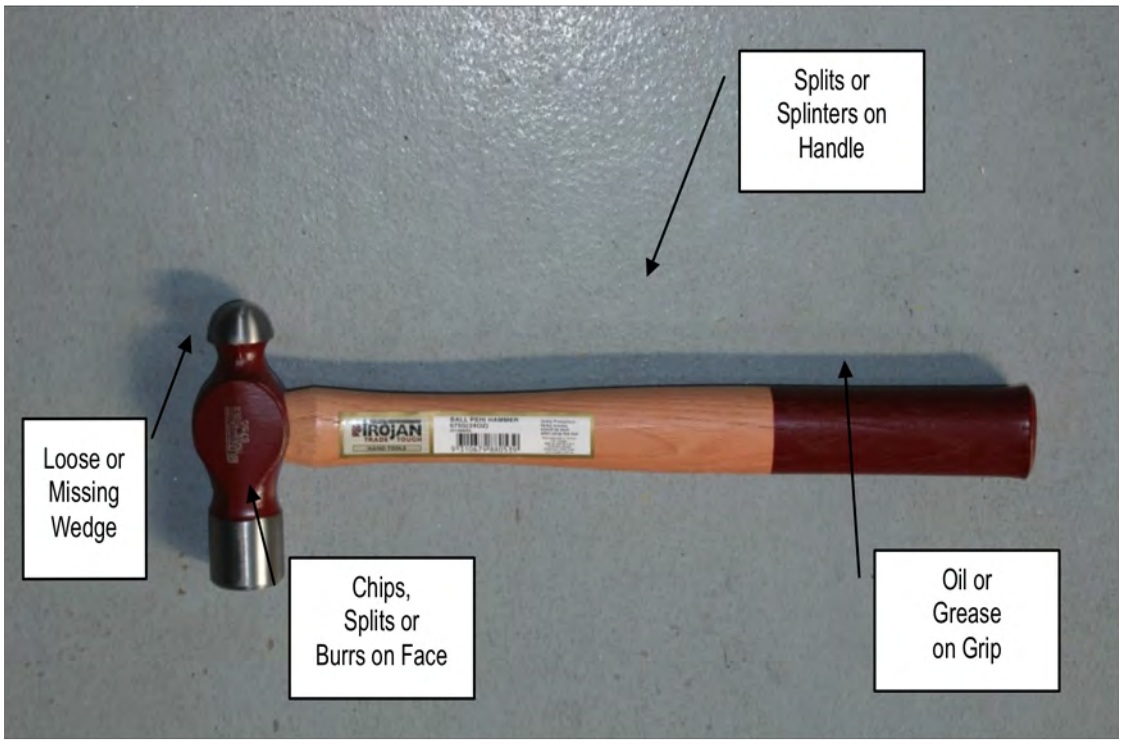
Using Hammers Safely

A damaged or dangerously used hammer can cause serious injury. It is important that you inspect every hammer you use and use the hammer for its intended purpose, swinging it in the correct manner.



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4.12 Cold Chisel and Punch

Two tools that are used for fairly simple tasks – cutting metal and marking metal for drilling.

Cold Chisel – Uses, Variety and Safety

The name cold chisel comes from its use to cold cut metal rather than heating the metal in a forge before cutting.

Cold chisels come in a variety of sizes, from fine engraving tools to massive tools that are driven with sledgehammers. There are four common types of cold chisel:

- The **flat chisel** used to cut bars and rods and to cut sheet metal which is too thick to cut with tin snips.
- The **cross cut chisel** is used for cutting grooves and slots.
- The **round nose chisel** is used for cutting grooves for oil ways in bearings.
- The **diamond point chisel** is used for cleaning out corners or difficult places.

Although the vast majority of cold chisels are made of steel, a few are manufactured from beryllium copper, for use in special situations where non-sparking tools are required. This could apply around vehicles with potential fuel or gas leaks.

Cold chisels require a reasonably powerful strike from a hammer to do cut or mark metal. Protective gloves can provide some protection. Accuracy and care are the two most important factors in using a cold chisel.

Punch – Uses and Safety

A punch **or 'centre punch'** is a hardened metal rod with a sharply pointed tip at one end. The opposite blunt end is struck by a hammer to mark the centre of a point where you intend to drill a hole. A steel tipped drill can 'wander' if it does not start in a recess.

There is little significant variation in centre punches except in size and strength.

Safety risks and controls are the same as the cold chisel with somewhat less risk of being hit when using a centre punch.

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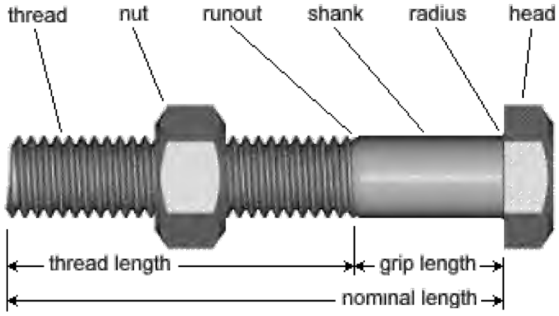
4.13 Fastening Hardware

WIKI – 'A **fastener** is a **hardware** device that mechanically joins two or more objects together.'



http://ktm950.info/how/assets/images/nuts_bolts.gif

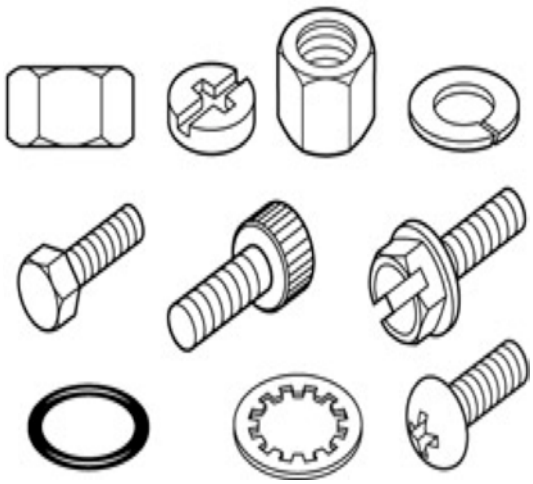
Application

A threaded fastener can be called a bolt or a cap screw. It is very recognisable with a threaded end and an opposing end with a, usually, hexagonal head for tightening. A threaded fastener with a slotted head is called a screw and these are also very recognisable.

Selection

The general and very important principle for nuts, bolts and screws is that the threads match so that the fastener can be screwed into place without causing any damage such as cross threading. Beyond that it is important that the whole fastening assembly is the appropriate size for the pieces it is fixing together. Too small and it may break. Too large and it may weaken the metal pieces it is attaching which could also result in a breakage.

Generally a designer will have made the selection on fastening in the original design. The auto-technician's task is to keep to those design decisions when doing repairs.



http://www.adobe.com/cfusion/exchange/index.cfm?event=extensionDetail&extid=1045681

Types

There are two broad categories – bolt (with or without nut) and screw. In these two categories individual fasteners vary from a few millimetres long in some electrical circuits to several hundred millimetres on heavy machinery.

Other variables include the metal/s used – steel, aluminium, brass; threads per inch – from 9 or 10 to 60 or more; and tensile strength – the ability to withstand tightening stress.

Washers are positioned between a bolt head or nut and the surface being fixed. The washer spreads the force of the screw or bolt over a larger area and creates more surface tension to prevent slipping.

Safety

The only substantial threat is a bolt or screw being tightened beyond its tensile strength and snapping. This could release metal shards which could injure an eye. Protective glasses should be worn along with normal workshop PPE.

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4.14 Drills

There are several types of portable drilling machines available. They all do the same basic task – drill holes. There are two main categories – battery and mains power. Battery drills are becoming so effective they are replacing mains powered drill in recent years.

Variety and Selection

Cordless Drill – Application and operation

- General drilling tasks.
- Single hand operation and mainly used for drilling small diameter holes.
- Doesn't require a lead making it easier to reach difficult points on a project.
- Can be used as a cordless screw driver.

Mains Power Electric Drill - Application and operation

- General drilling tasks.
- Single hand or two hand operation and mainly used for drilling larger diameter holes.
- Connecting to power means no risk of battery power source going flat.

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Drill Safety
Using a power drill is one of the more likely ways to be injured. You should learn and apply good safety practices when working with drills and related tools.

Safety

- Disconnect power before making any checks
- Chuck keys must not be attached to leads with metal wire because of the danger of an electrical short circuit if the lead is faulty.
- Select and set the correct speed for the job.
- Usually the smaller the bit the higher the speed needed; the harder the material being drilled, the slower the speed.
- With variable speed drills, experiment to find the best speed.
- Centre punch the drilling mark for hard materials.
- Fasten the work before drilling.

Operating

- Electric drills use the domestic power supply to provide power for drilling. The power is directed to the electric motor by a finger-operated trigger. The operating trigger can have a latch that will lock it into position.
- Some larger size drills can produce a large amount of torque. This can be strong enough to knock away the drill from your hand if it catches in the hole. Do not activate the locking latch so you can release the trigger if necessary.
- If the drill has a reversible gearbox, test the drill by turning it in the correct direction first. Forcing a drill bit to work while turning backwards will blunt the bit.
- If the metal tailings coming from the drill bit are becoming too long, release the pressure from the bit so the tailing can break off. Do not pick up the metal waste with bare hands. If you do, you risk a severe cut.
- If you are drilling through sheet metal, back off the pressure slightly as the drill breaks through so that it doesn't snag in the piece.

- If the component you are drilling starts to turn when drilling, stop the drill and tighten the component in the locking mechanism. Do not try to hold the component with your hand.
- Power drills use ball bearings that are designed to work against an axial load. The bearings cannot withstand large side loadings. Do not use the drill to elongate a hole.
- If you suspect the drill bearings are faulty, check that the bearings have no free play. If there is any free play, the bearings may fail.
- When you have finished using the drill, clean it with a dry cloth and return it to its storage area.

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4.15 Drill Bits

A drill is useless without a drill bit. The 'twist' drill bit is the type produced in largest quantity today. It can be used to create holes in metal, plastic, wood and stone. Twist drill bits are currently produced in diameters from 0.05 mm to 100 mm. Lengths range up to about 1000 mm for use in powered hand tools.

A drill bit is made up of the:

- cutting end, which is used to cut
- bit shank, which is held in the jaws of the chuck.

Common diameters for drill bits on most portable drills are between approximately 1.6mm to 13 mm. Numbers on drill bits are also common in the identification of the size of the drill bit.

Variety of Drill Bits & Related Tools

Types of Bit

Twist bits are made of several substances depending upon their purpose:

- Carbon steel is used on wood and soft metals.
- High speed steel bits are used on soft metals and mild steel.
- Tungsten carbide or carbide tipped bits cut concrete and hard metals.

Reduced Shank Drill

Allows larger holes to be drilled where there are limitations of chuck size

Morse Taper Shank

Bits or accessories are inserted into a tapered receptacle and pushed or twisted into place. They are then held by friction.

Centre Drill

Center drill bits are used in metalworking to provide a starting hole for a larger sized drill

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4.16 Power Wrenches

Battery Operated - Uses and features:
Used for tightening or loosening nuts or bolts. Usually only used on repetitive tasks

Power wrenches are either electrically or pneumatically powered. They are available in two basic types:

- Variable torque
- Reversible

Hexagon sockets to suit a complete range of nut sizes are available. Do not use normal sockets for these tools as they require heavy duty sockets.

Mains Power Operated Uses and Features:
Powered by mains electricity and of heavy construction. This type of tool would be used on large scale projects with a lot of repetitive and high-effort work.

Operating Guidelines and Safety – Power Wrench

- Disconnect power before making any checks
- Check the socket fits the nut or bolt correctly
- Snap the socket into place
- Test the tool briefly before attaching
- Wear appropriate PPE
- Use two hands to operate the wrench
- Allow the tool to move forward or back as the nut or bolt tightens or loosens
- When removing bolts place them carefully in a designated place before moving on
- Allow the wrench to stop before putting it down

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4.17 Grinders

Grinders are used to make a number of repairs to vehicles – cutting, smoothing removing. Many different types of machines are available but their operating principles are similar. There are many hazards associated with grinders. We will emphasise these hazards to ensure you can work safely.

Types of Grinders:

Angle Grinder

Uses and features:

A versatile tool sometimes referred to as a 'power Swiss army knife'. Angle grinders are used to:

- Remove welding bead deposits.
- Cut mild steel panels.
- Remove brackets that have been welded on.

Bench Grinder

Uses and features:

While the bench grinder is not a hand held power tool it is used in the vehicle industry for:

- shaping
- smoothing
- sharpening
- cleaning up and chamfering rough edges.

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Grinder Operation
Angle grinders are one of the most commonly used tools in a workshop. Here are some general facts worth noting:

- The grinding wheel can be used on its edge. This makes it particularly useful for grinding in awkward areas and it also can be used to clean out small dents in sheets before filling them.
- Angle grinders come in different sizes: a 100 -125 millimetre diameter and a larger 180 - 230 millimetre grinder.
- The 100 - 125mm angle grinder is a small all round angle grinder which is used for grinding welds and overhanging parts and de- rusting in confined spaces. It can also be used for single handed operations.
- The 180 - 230 mm angle grinder is a larger version of the 100 - 125mm diameter angle grinder. It is designed for heavy grinding operations and needs to be held with two hands when it is being used.
- Speeds in revolutions per minute (RPM) can vary with each machine. Check that the machine speed is not greater than the maximum RPM of the disc.

Operating and Safety – Grinders

- Disconnect power before making any checks.
- Check that the grinder and its lead are in a serviceable condition.
- Place the material to be ground in a vice or clamped to a bench.
- Stand in a well balanced position with a clear view of the material.
- Always check that the wheel is properly secured.
- Point the grinder downwards when starting it up. Hold it firmly, because of a possible kick back.
- Use a backwards and forwards motion across the surface being ground.
- When using the large angle grinder keep both hands on the machine.
- Do not remove the guard.
- Never put the machine down until the wheel has stopped rotating.
- Always place the grinder with the disc facing down.

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4.18 Air or Pneumatic Tools

Pneumatic Power Wrench

Uses and features:

Similar to the cordless wrench. Air powered for greater safety and less noise. Commonly used in large scale production.

Pneumatic Vertical Grinder/Polisher (Body Work)

Uses and features:

The advantages are that air power makes these tools safer and compact design makes them easier to use. They do roughly the same tasks as an angle grinder.

Air or Pneumatic Drill

Uses and features:

General drilling tasks. Single hand operation and used for drilling a wide range of hole diameters. Light weight and quieter to use. They are safer in an environment with flammable materials

Operation and Safety

All the general operational and safety measures apply to this group of tolls.

Of particular importance is the danger posed by air under high pressure. This can cause a number of injuries including embolisms – air bubbles inside the body – very easily. An embolism can result in death. For this reason air hoses should never be directed at other people or your own body.

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4.19 Lifting Equipment - Jacks and Supports

Application
A vehicle can be lifted by a hydraulic jack to allow easier access when getting under cars or on wheels. The jack uses the hydraulic principle that a large action with small effort on the jack handle produces a small reaction with large effort at the lifting point. To put it another way the jack uses hydraulics to get a mechanical advantage and lift the car easily.

Before doing any work on the vehicle the jack should be replaced with a more permanent support such as jack or safety stands. The hydraulic jack is not reliable for lifting in the long term. Hydraulic fluid can leak through seals and the vehicle could drop to the floor causing injury.

Types and Selection
There is very little range of choice in hydraulic jacks and jack stands. Size and quality of manufacture are the two main variables. Ensure that the equipment you use meets the required standards - AS/NZS 2693 Vehicle jacks, with variations.

Safety
A failed lift has the capacity to cause severe injury or death. The following points set out the main risks:

- Never rely on a hydraulic jack when working under a vehicle.
- Always lift on a firm and level surface.
- Use jack stands when working under a vehicle.

Check lifting equipment against AS/NZ standards (It should be on the equipment identification)

Activity – Video:
Don't be a jackass - an 'anti-manual' for using a car jack

http://www.productsafety.gov.au/content/index.phtml/itemId/989891/fromItemId/974732

Gives some tips on safety when lifting cars.

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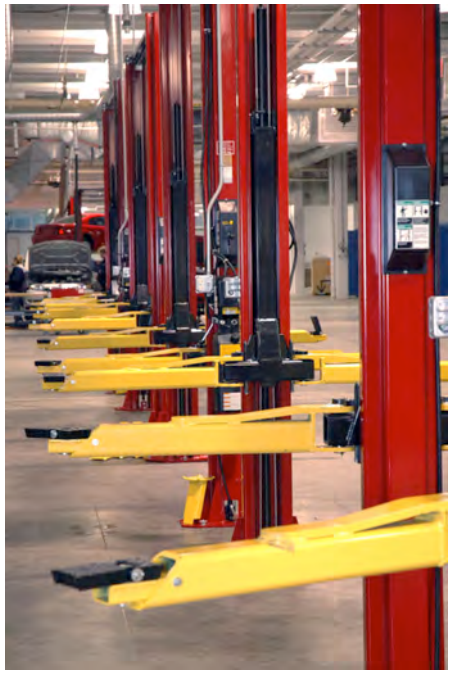
4.20 Lifting Equipment - Hoists

Application
Hoists give the best possible access to the underside of a vehicle allowing easy servicing and repairs. All work is at floor level increasing safety by reducing trips, falls or injuries from working on creepers – a creeper is a wheeled trolley that a mechanical technician can lie on when working under a vehicle. Hoists lift using electrically driven motors which pump hydraulic fluid to lifting cylinders. They're capability is usually in the range 3200 kg to 5400 kg. This is clearly marked on the hoist. It is important to lift from the correct points on the vehicle – usually indicated on the vehicle or in the service manual.

Selection
Hoists are usually installed well before any day to day decisions are made about selection of a hoist. The choice may be between several hoists of differing capacity. The chosen hoist must be rated above the weight of the vehicle being lifted. Beyond that the choice should be for the hoist with greatest capacity of those available.



Types
We have seen that there are hoists of different capacity. Some older hoists use air instead of hydraulic fluid to lift. Any hoist you use must meet the AS/NZ standards.

Safety
Hoists do present a potentially fatal risk if they fail. Controls include:

- Don't use a hoist unless it is the best method available
- Ensure the hoist meets the required standards
- Check that the hoist is in good service – periodic checks have been completed
- Alarms are working
- Minimise time spent under the hoisted vehicle

Lifting Demonstration Videos– YouTube
There are several useful videos showing vehicle lifting techniques. Here are the URLs for:

A Video on a new type of safety stands - http://www.youtube.com/watch?v=Dcjw_VIX2fc

A video on using a hoist - http://www.youtube.com/watch?v=_sAuM242hW4

Note the first lift uses the tyres as a lifting point while the hoist used the strengthened 'lifting points; on the vehicle chassis.

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4.21 Other Tools and Equipment

There is an almost endless list of tools and equipment used in an automotive workshop. You can't be expected to know them all this early in your career. We have included brief details for several more items that you may come into contact with. You may already have the relevant knowledge about how to safely handle these items. It would have been covered in the WHS/OHS unit.

Sealing and adhesive equipment –
Treat sealing and adhesive materials as hazardous substances. Use the MSDS sheet that comes with each hazardous product as your guide for handling these substances.

Screw Extractors

Application
Screw extractors – often referred to as Easy Outs – are used to remove broken or seized screws. The broken screw is drilled out by a small diameter screw. The screw extractor drill bit with a reverse thread is then screwed into the hole in an anticlockwise direction and by hand. As it does, it releases and removes the seized screw.

Wikipedia Image - http://en.wikipedia.org/wiki/File:Damaged_screw_removers.jpg

Selection, Types & Safety
There are a small range of 'easy out' products. They all achieve the same result and have a less than 100% success rate.

The safety principles are the same as operating a power drill – safety glasses are essential along with workshop PPE.

Gear Pullers
This is a research exercise. Use your usual information sources to find out what a gear puller does. (The name is a bit of a giveaway)

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